DaimlerChrysler AG

Patent claims

1. An internal combustion engine, with
   - a control unit (16) and a combustion space (8) formed between a piston (5) and a cylinder head, and a fuel injection device with an injection nozzle (13), which has a nozzle needle (13a) and a plurality of injection bores (21),
   - fuel being injected by means of the injection nozzle into the combustion space (8) in the form of a plurality of fuel jets (17) as a main injection and, if appropriate, as a preinjection and/or postinjection,
   - the injection bores (21) of the injection nozzle (13) being arranged in at least two different separately activatable rows of holes, and
   - an operating stroke of the nozzle needle being capable of being set by means of the control unit as a function of a piston position (φ) and/or of an operating point of the internal combustion engine (1).

2. The internal combustion engine as claimed in claim 1, characterized in that the rows of holes of the injection nozzle (13) have different injection-hole cone angles (α).

3. The internal combustion engine as claimed in claim 1 or 2, characterized in that a first row of holes (L_{R1}) of the injection nozzle (13) is activated during main injection and a second row of holes (L_{R2}) is activated during preinjection and/or postinjection, the injection-hole cone angle of the first row of holes (LR_1) being higher than the injection-hole cone angle of the second row of holes (LR_2).

4. The internal combustion engine as claimed in one of the preceding claims, characterized in that a fuel injection pressure can be set as a function of the piston position (φ) and/or of an operating point.

5. The internal combustion engine as claimed in one of the preceding claims, characterized in that the operating stroke of the nozzle needle (13a) of the injection nozzle can be set in such a way that an unstable cavitating flow is formed in the injection bores (21) of the injection nozzle (13).

6. The internal combustion engine as claimed in one of the preceding claims, characterized in that a swirl movement can be set in the combustion space.

7. The internal combustion engine as claimed in one of the preceding claims, characterized in that a generated fuel cloud of a fuel jet (17) is offset or laterally displaced by means of the swirl movement set in the combustion space, in particular during a fuel injection carried out intermittently.

8. The internal combustion engine as claimed in one of the preceding claims, characterized in that the operating stroke of the nozzle needle (13a) of the injection nozzle (13) is set in such a way that, within the injection nozzle (13), an effective flow cross section between the nozzle needle (13a) and a nozzle needle seat (22) amounts to about 0.8 to 1.2 times an effective flow cross section of the sum of all the injection bores.

9. The internal combustion engine as claimed in one of the preceding claims, characterized in that the injection-hole cone angle between the injected fuel jets (17) amounts to between 60° and 160°.

10. The internal combustion engine as claimed in one of the preceding claims, characterized in that the operating stroke of the nozzle needle (13a) can be set by means of a two-spring holder, a piezoelectrically controlled nozzle needle or a coaxial varionozzle.

11. The internal combustion engine as claimed in one of the preceding claims, characterized in that the piston has a piston recess which is of dish-shaped design, a projection extending from the center of the piston recess in the direction of the injection nozzle.

12. The internal combustion engine as claimed in one of the preceding claims, characterized in that the piston recess has, starting from the piston head, first, a flat entry with a low curvature and, from the region of the maximum recess depth, a greater curvature extending into the piston recess projection.

13. The internal combustion engine as claimed in one of the preceding claims, characterized in that the piston recess projection has a cone angle in a range of 90° to 140°.